1903.—No. 3.

DEPARTMENT OF THE INTERIOR.

BUREAU OF GOVERNMENT LABORATORIES.

BIOLOGICAL LABORATORY.

A PRELIMINARY REPORT

ON

TRYPANOSOMIASIS OF HORSES

IN THE PHILIPPINE ISLANDS.

By W. E. MUSGRAVE. M. D.,
Acting Director Biological Laboratory,

AND

NORMAN E. WILLIAMSON,
Assistant Bacteriologist, Bureau of Government Laboratories.

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LETTERS OF TRANSMITTAL.

OFFICE OF THE SUPERINTENDENT
OF GOVERNMENT LABORATORIES,
Manila, P. I., March 27, 1903.

SIR: I have the honor to transmit herewith a preliminary report on trypanosomiasis of horses in the Philippine Islands, by W. E. Musgrave, M. D., and Norman E. Williamson.

I am, very respectfully,

PAUL C. FREER,
Superintendent Government Laboratories.

Hon. JAS. F. SMITH,
Acting Secretary of the Interior, Manila, P. I.

BIOLOGICAL LABORATORY,
Manila, P. I., March 26, 1903.

SIR: In compliance with your request, I have the honor to submit herewith "A preliminary report on trypanosomiasis of horses in the Philippine Islands."

Very respectfully,

W. E. MUSGRAVE, M. D.,
Acting Director Biological Laboratory.

Dr. PAUL C. FREER,
Superintendent of Government Laboratories.

PRELIMINARY REPORT ON TRYPANOSOMIASIS* OF HORSES IN THE PHILIPPINE ISLANDS.

[By W. E. Musgrave, M. D., Acting Director of the Biological Laboratory, and Norman E. Williamson, Assistant Bacteriologist, Bureau of Government Laboratories.]

1. History of the epidemic in the Philippine Islands.
2. Mode of transmission and infection.
3. Symptoms and diagnosis.
4. Preventive measures.

Numerous requests for information regarding trypanosomiasis, the paramount economic importance of the disease to this country and the urgent need of rational systematic work, supported by proper legislation looking to the control and eradication of the infection from this country and the avoidance of reinfection, are the principal reasons for this preliminary report.

This report is intended to be a brief synopsis of facts regarding the disease. Evidence for abstract statements, not found in the voluminous literature of the subject, will be discussed in a paper from this laboratory, now being prepared, which will deal with the whole subject of trypanosomiasis in a more exhaustive manner. Technical terms, detailed descriptions of experiments, discussions of theories and other statements of interest to the investigator, but which would tend to make this report less intelligible to the lay reader, to whom it is particularly addressed, have been eliminated as far as possible.

HISTORY OF THE DISEASE IN THE PHILIPPINE ISLANDS.

The first published report relating to what was afterward determined to be trypanosomiasis was "A preliminary note on a parasitic disease of horses," by Smith and Kinyoun, dated Manila, October 17, 1901, and published first as a bulletin from the Army Pathological Laboratory, October 17, 1901.

* "Surra," nagana, tsetse-fly disease, mal de caderas, mal de coit, dourine, pjudi, etc.

In General Order No. 390, Headquarters Division of the Philippines, dated December 11, 1901, in addition to a republication of Smith and Kinyoun's preliminary note, are some additional notes by Smith, in which he states the disease to be identical with the well-known "surra" of India and Burmah. The mode of infection is unknown, but the parasite is probably introduced through the bite of some suctorial insect, such as the fly or mosquito. The animals were generally killed upon the supposition that they had glanders.

Smith's recommendations are that horses suffering from the disease should be isolated at a distance of at least half a mile from healthy animals, and that the blood of all suspected of glanders be examined before making recommendation for disposition. This was a serious mistake, and particularly so at a time when the epidemic was comparatively limited. It would have been far better to have continued to kill these animals for glanders, or what not, so long as they were promptly destroyed. The isolation of the sick ones at a distance of half a mile from those which were healthy was not a practical procedure and could not but result in establishing new foci of infection.

In a letter of transmittal, published in Bulletin No. 42, Bureau of Animal Industry, Department of Agriculture, March 29, 1902, J. G. Slee, assistant veterinarian, Board of Health, Manila, mentions a "new" disease as appearing in the Philippine Islands during 1901. He states that the parasites were first observed in the blood of a horse taken by him to the laboratory of the Board of Health. The report accompanying the letter of transmittal was first published in the American Veterinary Review, New York, January, 1902. In Bulletin No. 42, Bureau of Animal Industry, Salmon and Stiles quote Kinyoun as follows: "From what I can learn the disease surra appears to be distributed all over Luzon and has been there for many years. No one seems to know where it came from. I do not think it came from China, as no cases have been reported in Hongkong, where a considerable number of artillery horses are kept."

In commenting upon the above reports and correspondence, Salmon and Stiles write that "according to information received from Dr. Kinyoun, the disease is beyond question surra, and that Mr. Jobling made the first observation on the disease in Manila." Discussing the origin of surra in the Philippine Islands, they say: "Our information from Manila is not yet sufficiently detailed to

enable us to judge with certainty whether surra has existed many years there or whether it was recently introduced. If it has been recently introduced, it seems very possible, from our present incomplete data, that it was carried to China by the English troops from India, and that our troops carried it from China to the Philippines. * * * From present accessible data, it does not seem to be entirely established that the disease mentioned as existing in previous years was of the same nature."

Curry, in American Medicine, March 29, 1902, writes that much to his surprise he found surra parasites in the blood of two carabao. One of these animals was suffering at the time with an injured leg, but nothing is stated about the subsequent course of the disease in either of the animals. After remarks upon the epidemic of rinderpest in cattle and carabao in the Philippine Islands, he states: "It is very probable that the cattle epidemic is surra and not rinderpest, and that the disease among horses and mules had its origin from infected carabao or other cattle."

Careful investigation fails to give even the slightest evidence in support of Curry's conclusion. In the first place, rinderpest and trypanosomiasis have practically nothing in common. From a clinical standpoint, they have classical symptoms which are so radically different that it is not understood how they could be confused. That rinderpest and not surra is the epidemic which has destroyed so many thousands of cattle and carabao in these islands during the last three years has been amply demonstrated. This has been proved by the fact that preventive methods of inoculation have eradicated rinderpest from certain sections of the country and daily contact with infected animals at the Serum Laboratory has left no shadow of a doubt. The Honorable Civil Commission are now considering a proposed law making compulsory the inoculation against rinderpest of all cattle and carabao imported into this country.

It is a well-known fact that trypanosomiasis is found in cattle, buffaloes, etc., and there could be nothing surprising in its occurrence in carabao. So far, however, as the Philippine epidemic is concerned, it is exceedingly rare in these animals, for in the examination of the blood of a considerable number of cattle and carabao, sick and well, extending over a period of six months, the parasites have not been found, and none of these animals have shown symptoms of trypanosomiasis. It must be remembered that our work

was commenced in September of last year, toward the close of the rainy season, and has been continued through the cool and dry weather. It is not unlikely that we may find some cases of trypanosomiasis in bovines when the next wet season begins, especially if search is made in animals with exposed wounds.

In American Medicine, July 19, 1902, Curry writes: "I am unable to give accurate figures as to the number of animals destroyed by this disease, which in certain places has been a veritable plague. Among horses and mules of the Quartermaster's Department and the cavalry horses, considerably over 2,000 animals have died during the past six months, from July 1 to December 31, 1901, the largest percentage from surra. In the Provinces of the Camarines and Albay the loss among native ponies has been very severe. Some pueblos in these provinces are now practically without horses or carabao. Thousands of ponies have died in this section of the island alone."

The writings relating to trypanosomiasis in the Philippine Islands have been reviewed somewhat in detail because some of this work is confusing and uncertain, and leaves the question of priority in the discovery of the disease here in an unsatisfactory state. There can be no question that Dr. J. W. Jobling, Director of the Serum Laboratory, was the first to observe the parasite in the blood of horses in the Philippine Islands. Smith and Kinyoun mention this fact in their preliminary report and Dr. Kinyoun further corroborates this in a letter to Salmon and Stiles. Veterinary Surgeon Slee took the specimen of blood to the laboratory for examination, as stated in his report mentioned above, but he does not mention Dr. Jobling as having made the examination.

In a personal conversation, Dr. Jobling informs us that on October 15, 1901, Dr. Slee brought him a specimen of blood from a horse to examine, and that he found numerous parasites with which he was not familiar. While looking up the literature, Drs. Smith and Kinyoun came into the laboratory, looked into the focused microscope and asked him what he had. He told them that he had not yet determined; that it was horse's blood containing parasites unknown to him. Dr. Jobling did not then publish anything in regard to the parasite or the disease, and has not as yet done so.

Two days later, Smith and Kinyoun wrote their preliminary note, which was published as mentioned above. This communication, however, contains many inaccuracies, in the description both of the

disease and of the parasite, and had it not been followed later by more complete and accurate work of other observers, it is doubtful whether subsequent writers would have considered the article in a discussion of the question of priority in the discovery of trypanosomiasis in the Philippine Islands, and even now no accurate description of the parasite found in this country has been given. Under description of the disease, Smith and Kinyoun state that impairment of appetite, constipation and fever of 104° to 107° are early symptoms; that it may terminate fatally or by slow convalescence; that the mortality in American horses is about 75 per cent; that at postmortem the organs are pale but otherwise normal in appearance. In the description of the parasite, they say that it is a whip-like worm, having much the appearance of a trichocephalus dispar, 10–14 microns in length; that the neck is nearly half its length, tapering gradually to a point representing the mouth (?), etc.

Veterinary Dr. Slee's description of the disease, while very brief and containing errors, is more accurate than that of Smith and Kinyoun, but his description of the parasite, as that of Smith and Kinyoun, is certainly not diagnostic.

In discussing the history of trypanosomiasis in this country, one of the first questions to be decided is whether the disease was introduced during 1901, the year in which it was discovered, or whether it had existed here prior to that time. The most careful and searching investigation fails to show any tangible evidence that it existed here before May or June, 1901. During the year 1900 and the early months of 1901, the blood of many sick and healthy horses was examined at the Army Pathological Laboratory by Strong and Musgrave, as a matter of routine, and had trypanosoma been present, they would in all probability have been seen. Investigation of some of the statements asserting the existence of trypanosomiasis before 1901 makes it certain that the diseases mentioned were not trypanosomiasis. Kinyoun's argument that the disease was not imported from China, as suggested by Salmon and Stiles, because there is no surra in China, is a good one, and is fully borne out by the facts obtained in the present investigation. It is hardly possible that a disease so readily transmissible could pass through a country that was at the time a theater of war, where thousands of horses of many nations were present, without leaving an epidemic in its wake. The disease has not been reported as occurring in

China; animals coming here from Chinese ports show no infection, and we are assured by several competent authorities that the disease trypanosomiasis is not known there.

Since we are satisfied that trypanosomiasis did not exist in the Philippine Islands prior to May or June, 1901, and also that it did not then exist, nor has it since existed in China, we should naturally expect to find its admission into these Islands through animals coming from some infected port.

Through the courtesy of the Custom House authorities and Veterinary Surgeon Richards of the Insular Board of Health, we have obtained the date of arrival, point of embarkation, consignees, total number and kind of animals received into this country during the six months immediately preceding the first recognized case of trpanosomiasis. The subsequent history of each lot of these animals was traced as far as possible, to determine any possible connection with the epidemic.

A lot of circus animals of the usual variety arrived here on March 7 from Singapore, having been a month in Hongkong, and remained in this city for about six weeks. No epidemic followed in Hongkong, and they could not be connected with the epidemic here, but realizing that they had been in infected ports, and that some wild animals may harbor the trypanosoma, probably for years, without serious inconvenience to themselves, the possible connection between this circus and the epidemic has been carefully studied. While they were in Hongkong, the weather was too cold for flies to be about in any numbers, so that no connection can be traced between animals from that country and the subsequent infection in the Philippines.

During May, 1901, there were received from Australian ports 26 head of horses, a number of which were race horses, and some of them were sent to Pasay race track in Manila. One of the seven horses received on May 4 was ill at the time of landing and subsequently died of what is now generally known in these islands as "surra." The next animal known to be infected was a race horse stabled on Calle Uli Uli, which had been on the Pasay track, and which was taken ill during the latter part of May, 1901. A second and third horse in these stables and another stabled at the race track developed the disease and died; one of these horses for some weeks before his death was stabled in Malate district and was treated at the pony corral in old Manila. About this time the

disease appeared among the cavalry horses at Pasay (just across the street from the race track), in the pony corral, and in stables in Malate near those in which the sick horse had been placed and also where some other race horses were stabled. From these points the infection spread rapidly, and through shipment of animals was soon transferred to large areas of the country.

The annual report of Colonel C. F. Humphrey, Chief Quartermaster, Division of the Philippines, for the fiscal year ending June 30, 1902, states that 3,693 animals died or were killed because of disease during the year, and that glanders and "surra" were responsible for most of the havoc. In answer to a letter asking for information, Colonel Humphrey writes that 1,305 horses and 672 mules died or were killed on account of "surra," glanders, and other diseases during the calender year 1901, and 2,318 horses and 1,492 mules during 1902, or a total loss of 5,787 animals during the two years. The exact number of cases of trypanosomiasis in this lot is not given, but it is certainly very large. No accurate figures are obtainable giving the losses among the horses of the Civil Government and of private persons, but enough is known to show that these were very heavy. A conservative estimate of the money value of losses in horses alone, to say nothing of the indirect ones resulting from their death, would not be less than $2,000,000.

MODES OF TRANSMISSION AND INFECTION.

So far as direct evidence goes, trypanosomiasis is a wound disease. The infectious agent must come in contact with a wounded surface, either skin or mucous membrane, and when these requirements are fulfilled, no matter how, in susceptible animals, the disease is the result. A study of the modes of infection, then, consists in a study of the practical methods by which infectious material is brought into contact with wounded surfaces.

Biting flies have been, for ages, considered a means of transmission of the disease by natives in Africa and in certain districts of India, and these assertions have received the support of nearly all scientific writers on the subject for more than fifty years.

Absolute proof of this manner of transmission has been furnished from Africa, India, South America, and other countries, and these observations have also been confirmed in the present investigation of the Philippine epidemic.

The period during which flies are capable of transmitting the disease after feeding on infected blood appears to be less than forty-eight hours. After this time trypanosoma have rarely been found in their body juices; emulsions made from them and injected into susceptible animals have not produced the disease; and direct biting experiments with them have been negative. This seems to demonstrate conclusively two things: That the action of the fly is mechanical, and that the fly does not act as an intermediate host for the trypanosoma. This point has an important bearing upon methods of prevention in the spread of the disease, as will be shown when that part of the subject is discussed.

The conclusion that biting flies act simply as agents in the mechanical transmission of the disease forces us to regard all biting insects as dangerous. Even the common house fly, which does not bite, must be placed under ban, for in case of abrasion or other wounds on infected animals, and where healthy animals, also with abrasions, are in close proximity, the house fly can carry the infection on its legs from one wound to the other, just as it is known to carry the germs of typhoid fever, dysentery, cholera, and other diseases from dejections and other infected substances to our food and drink.

A varying percentage of rats are known to harbor a trypanosoma somewhat resembling the one found in the horse, and it has been conclusively shown in the present investigation that a certain number of rats in Manila harbor the same trypanosoma which causes the disease in other animals. These parasites have been determined both morphologically and in their pathogenic action to be identical with the parasite causing trypanosomiasis in horses.

Lingard claimed that some of the rat trypanosoma of India were pathogenic for the horse, but we are tempted to think that some of his rats were infected with *Trypanosoma evansi,* though he does not say so, just as are some of those in Manila. This explanation would clear up some of the confusing results arrived at by this author in regard to rat trypanosomiasis, and if true, would also add significance to the discovery that these animals in Manila occasionally harbor *Trypanosoma evansi.* It would also make very probable the the suggestion that the disease Lingard thought transmitted by rat excreta in grain fed to horses was in reality transmitted by insects from rats infected with *Trypanosoma evansi.*

Rabinowitsch and Kempner proved that fleas were capable of transmitting the rat trypanosoma from rat to rat, and with this knowledge in view, we must also consider fleas capable of transmitting the "surra" parasite not only from rat to rat, but also from infected rats to horses, especially to those with wounds of any kind.

For practical purposes, *until investigators have shown exactly what insects are capable of transmitting the disease, all insects, including flies, fleas, lice, mosquitoes, etc., should be considered as agents in the spread of the disease and should be taken cognizance of in recommendations and procedures for its control.*

The great majority of writers agree that infection can not take place through the sound mucosa of the alimentary tract and that the occasional infection following the administration by mouth of the virulent blood and organs of animals recently dead of the disease are probably due to the fact that these animals had damaged mucous membranes of the mouth or upper part of the alimentary canal, which would, of course, result in infection, just as would occur in any other part of the body by bringing an injured surface into contact with infectious material, or vice versa.

In nearly all feeding experiments, large doses of the infective agent have been given, and in this sense they have not approached natural infection, which, from the nature of things and whether administered through the mucous membrane or the skin, would be in small doses.

Lingard attempted infection through the digestive canal by the administration of very small doses of infected blood given frequently in large dilutions of water. One of his horses that had received such treatment, and in addition one dose of 13 c. c. of infected blood, developed the disease on the one hundred and thirtieth day after beginning the experiment. He fed a second horse 200 minims of fresh virulent blood at one dose, with an incubation period of seventy-five days. He does not state that these horses were protected from insects during the periods of the experiments, which were made in an infected country, and it is more than probable, considering the incubation periods of one hundred and thirty and seventy-five days, that his animals were infected in some other way.

So far as we have been able to discover, there is not in literature any absolute proof of infection through the sound mucosa by feeding.

In this preliminary report, but one of our many feeding experiments will be given.

Monkey No. 126—healthy adult male monkey—was isolated, temperature taken and blood examined daily for a week. The temperature remained normal and the blood negative for trypanosoma. After twelve hours' fasting, he was fed weekly for six weeks on cooked rice (the usual diet) soaked with fresh, warm virulent blood, rich in trypanosoma from different animals, at different feedings. On two occasions he was given to drink infected blood in weak potassium citrate solution, in which the tryanosoma live longer than in any other known solution outside of the body.

At the end of six weeks, the animal was apparently in good health, temperature had remained normal, and the blood free from parasites. In order absolutely to exclude the existence of infection, a drop of his blood was infected subcutaneously into another monkey, which remained well and was afterwards proved susceptible. During the feeding, the infected rice would often be stored in his chops and remain there for hours.

After proving the animal not infected at the end of six weeks, a small scratch was made in the mucosa of the mouth and he was again fed as before. The disease developed on the fourth day, as evidenced by rise in temperature and the presence of trypanosoma in the blood. He ran the regular course of the disease and died on the eighteenth day after inoculation.

Other possible means of mechanical transmission that suggest themselves are: The removal of a bridle from a diseased horse, especially one with a sore mouth, and placing it on a healthy animal; the changing of harness from an infected animal with sore shoulders or back to a healthy animal or the passing of a curry comb or brush over an injured surface in a sick animal and then over a healthy one with an injury of some kind.

The manner of perpetuation of an epidemic of trypanosomiasis in any country is a very important point in considering the prevention and eradication of the disease.

By the very nature of parasites and of parasitic diseases in general, we know that unless the disease is continuous, the parasite must have a natural host, or there must be a stage in its life cycle in which it can exist for an indefinite period outside the living body; otherwise the infection will disappear.

Many of the large tsetse fly areas are absolutely destitute of domestic animals and probably some of them have never had one within their borders, and yet the flies in these districts are capable of infecting domestic animals. As it has been quite conclusively shown that the fly is not capable of carrying the infection at most but a short time, it necessarily means that there is a source of infection from which the flies are supplied, and the natural inference would be that the native source of infection is the wild animals in which the country abounds. It has already been shown that some of these animals are susceptible to the disease and that others harbor the parasites with little or no inconvenience. It is very probable that, were inoculation methods instead of microscopic blood examinations used for diagnostic purposes, a much larger percentage of these wild animals would be found infected than has generally been supposed.

Conditions in certain sections of South America are very much like those in Africa, and the indications are that the epidemic is perpetuated there in the same manner.

In India some observers claim that the cow acts as a host for the parasites over the long dry period in which there are not enough cases in horses to continue the infection. The probabilities are that a number of wild animals which exist in at least certain districts of India aid in this continuation. It is claimed that in certain sections of the country there are two varieties of animals which live in the bush, are susceptible to rinderpest and foot and mouth disease, but are not known to have "surra," though they are in infected areas. At certain seasons the flies are so numerous that these animals seek the open for protection from them. It would be interesting to test the blood of these animals by inoculation to see whether or not they are free from trypanosomiasis. In India, camels also may play an important part in carrying the infection from one fly season to the next, as it is stated that these animals may live as long as three years after infection.

From the foregoing, and if the disease continues to spread, it is evident that the wild animals of this country must be considered in dealing with the epidemic. If a certain portion of them are not already infected, it is only a question of time until they will be, and another difficult point in the solution of the problem will thus be produced.

The part that rats play in perpetuating an epidemic has not yet been fully determined, but the fact that at this time, in the middle of the dry season, a considerable number of these animals are found to be infected, and with the knowledge before us that the infection may be transmitted from one rat to another by fleas, which are numerous on rats at all seasons of the year, makes it probable that these animals play a very important part in perpetuating the infection in the Philippine Islands and in other countries.

However, so far as the city of Manila is concerned, it does not appear necessary to leave the horse family to discover how the infection is perpetuated. Now, even during the dry season, one can, almost daily, see a horse, sick with surra, driven along the streets, and biting flies, although not by any means as numerous as during the wet season, are still plentiful enough to continue the infection.

The existence of an extra-corporeal stage of the trypanosoma, living on grass and in water in marshy places, in this stage taken into the stomach of susceptible animals eating and drinking in these localities, and from this organ or other part of the animal economy passing into the blood in the forms we recognize, is without sufficient evidence to warrant consideration in this paper.

Before leaving this subject, however, for a fuller discussion in a subsequent paper, it is proper to state that the trypanosoma quickly die under all tried environments outside the body of some living creature, and no evidence of their existence in water, on grass, or other similar places can be advanced. Both water and grass have been inoculated with large numbers of trypanosoma and have failed to convey the disease, after days, weeks or months, when fed to susceptible animals, and also when injected under the skin.

Malaria is similar to trypanosomiasis in that both are parasitic diseases and both are prevalent in low lying, marshy lands and during wet weather. Malaria was for ages attributed to the air, the water, etc., of these marshes, and it took years to make the public understand that all these conditions are harmless in producing it, provided the patient is protected from the bite of mosquitoes, so prevalent in these regions.

Take the epidemic of trypanosomiasis in Manila. At the time of its outbreak and for some time afterwards, it was confined to the city. The grass and water given the horses was the same which had been fed for years, and no disease resulted.

The disease started from a focus of infection and spread directly with exposure to infected animals, and attacked alike animals fed exclusively on hay and on oats and those fed on grass. The disease is prevalent in Manila at the present time and has been so continuously since its introduction. The majority of the horses having the disease, under our observation for the past four months, had previously been fed entirely on hay and oats.

In one large stable, with both American and native horses, four of the American horses and mules (fed entirely on dry feed) and two of the native ponies have died of the disease and one of the two ponies was the only horse of this class in the stable which received dry feed only.

The statement is made that certain districts in India are avoided by cavalry troops on the march because of the danger in these districts from food and drink through which the animals may contract the disease. Similar conditions are found in South America, but in addition it has been shown that infected districts on this continent are just as dangerous to horses provided with dry food and pure water while passing through them as they are to animals eating forage grown on the spot.

It has been shown by a number of observers that an infected animal taken to a new place becomes a focus for the spread of the disease, provided biting flies are present, no matter whether the territory is marshy or dry. All animals in marshy places do not contract the disease, although they drink the same water and eat the same food, and yet all workers agree in believing horses to be susceptible invariably.

If it were possible to destroy every infected animal in the Philippine Islands and to protect the remaining ones from infected flies for forty-eight hours, there would never be another case of "surra" in this country unless it were introduced again from an infected locality. The same conditions existing before its introduction would be reproduced and animals could go on eating grass and drinking the water as before, notwithstanding "floods, inundations and storms." Biting flies and other insects would be harmless, because there would be no infected material for them to feed upon.

Of course, all infected animals can not be destroyed at once, but it can be done gradually, and the same result accomplished. This should be our method of warfare against the disease, and now is the

time to begin, before the rains again hatch out millions of biting flies rapidly to increase the number of cases. During the present dry weather, while comparatively few cases exist, a systematic examination of all animals and the destruction of those found infected would prevent a great increase of the disease, which, without some such effort, is sure to reappear with the season of flies.

It is not possible, from a practical standpoint, to destroy all flies, and were it possible, it is much easier and simpler to render the flies harmless by destroying the sources of infection. The diseased horse is less than worthless, for he is sure to die and to preserve him is both a waste of food and a menace to other animals.

There is another point in this connection which already adds materially to the seriousness of the situation, and this is the fact, already mentioned in this report, that a certain number of the "Manila rats" are infected with the trypanosoma of the horse epidemic. Just what part these little pests are going to play toward perpetuating the epidemic and in the spread of the disease in horses is difficult to foresee. The question is still under study and will be more fully considered in the completed report. The destruction of rats in Manila on account of bubonic plague will probably accomplish the additional result of lessening the sources of infection for surra.

SYMPTOMS AND DIAGNOSIS.

During the incubation period, i. e., the time between the date of infection and the rise of temperature with the appearance of the parasites in the blood, there are no symptoms of moment.

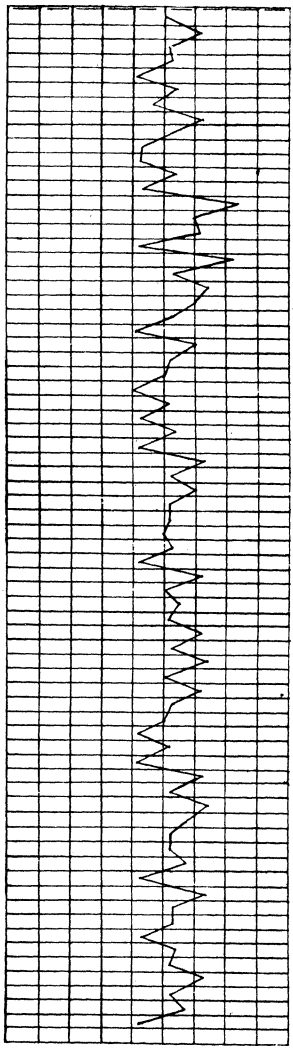
In experimental animals, after four to six days of incubation, and in naturally contracted cases, after an unknown period, which is, however, in all probability the same as with experimental ones, the temperature rises and trypanosoma appear in the blood. Further than slight symptoms, as thirst and some dejection, there are usually no other marked symptoms of illness for several days.

The course of the fever is neither regular nor constant; it may rise rapidly to 40° C. or more and become remittent or even intermittent from the start. More often it remains above 39° C. from one to three days, and then becomes remittent, or less frequently, intermittent; toward the end of the disease, the temperatures become more constant, being remittent and ranging from 38.5° to 40.5° C.,

always higher in the afternoons. In observations on a large number of animals we have seen no cases in which the temperature suggested true relapsing fever.

Pony No. 110 December 17, 1902.

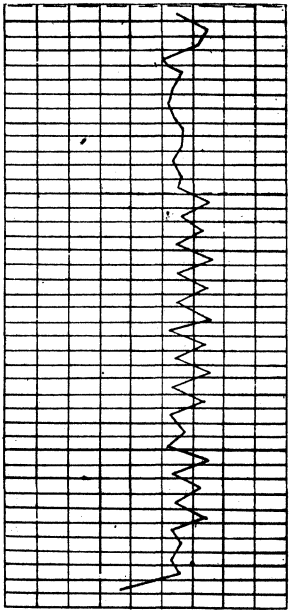
[Age, 7; sex, male; inoculation, admitted with trypanosomiasis; history, gray pony in good condition; early in the disease when received.]



Action.	Date.	Results.
	Dec. 17	Blood, positive trypanosoma.
	18	Negative trypanosoma.
	19	Negative trypanosoma.
	20	Negative trypanosoma.
	21	A few trypanosoma.
	22	
	23	Positive trypanosoma.
	24	Numerous trypanosoma.
	25	
	26	Very numerous trypanosoma.
	27	
	28	
	29	
10 c.c. fortified goat's serum, subcutaneously.	30	Positive trypanosoma.
	31	Positive trypanosoma.
	Jan. 1	
50 c.c. fortified goat's serum, subcutaneously.	2	
	3	Very numerous trypanosoma.
	4	
	5	Very numerous trypanosoma.
	6	Very numerous trypanosoma.
	7	
	8	Very numerous trypanosoma.
	9	Very numerous trypanosoma.
	10	
	11	
	12	
	13	Numerous trypanosoma.
	14	
	15	Numerous trypanosoma.
	16	
	17	
	18	Positive trypanosoma.
	19	
	20	
		Nearly dead when killed.

Mule No. 178, February 4, 1903.

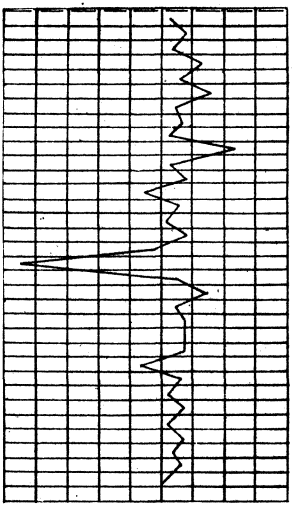
[Age, 7; sex, male; inoculation, admitted with trypanosomiasis; history, large, dark-colored American mule, well advanced in the disease; has been fed entirely on dry food.]



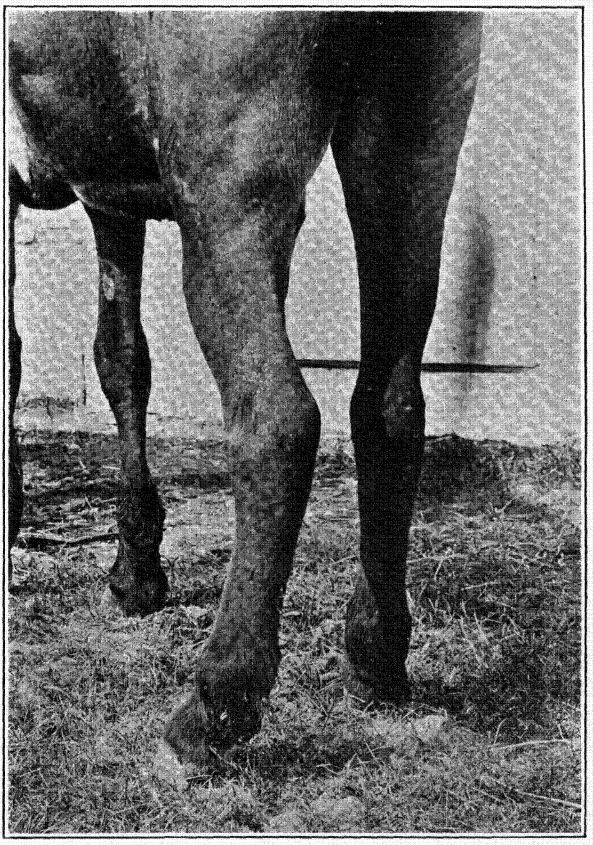
Action.	Date.	Results.
No treatment.	Feb. 11	Positive trypanosoma.
	12	Positive trypanosoma.
	13	
	14	
	15	
	16	
	17	
	18	Positive trypanosoma.
	19	
	20	
	21	
	22	
	23	
	24	Positive trypanosoma.
	25	
	26	
	27	
	28	
	Mar. 1	
	2	
	3	Dead.

Mule No. 151, January 12, 1903.

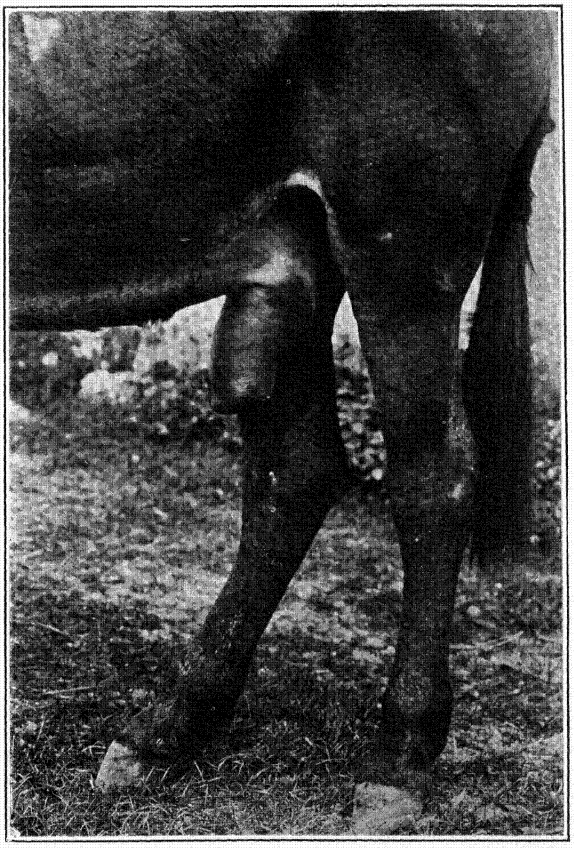
[Age, 9; sex, male; inoculation, admitted with trypanosomiasis; history, large, mouse-colored American mule, well advanced in the disease; has been fed entirely on dry food.]



Action.	Date.	Results.
Treated for five days with quinine.	Jan. 12	Positive trypanosoma.
	13	Positive trypanosoma.
	14	Positive trypanosoma.
	15	Positive trypanosoma.
	16	Positive trypanosoma.
	17	
	18	
	19	
	20	
	21	Positive trypanosoma.
	22	
	23	
	24	Positive trypanosoma.
	25	
	26	
	27	
	28	Dead.



MULE No 178, WELL ADVANCED IN THE DISEASE, SHOWING EDEMA OF HIND LEGS AND BELLY.



MULE No. 178, WELL ADVANCED IN THE DISEASE, SHOWING EDEMA OF GENITALS, BELLY AND LEGS.

One of the first symptoms noticeable is the increasing pallor of the mucous membranes, which may usually be noticed within a week after the onset, and which progresses rapidly. The membranes become pearly white and later take on a yellowish tinge. Petechiæ of the mucosa of the eye and nose are frequently noticed and may appear at any stage of the disease. Catarrhal discharges from the nose and eyes of a straw-colored serous fluid, which may subsequently become more opaque and tenacious, is a frequent symptom, but the quantity or the character of the discharge would not lead one to think of glanders. The submaxillary and sublingual glands are often swollen; rarely, however, to any very considerable extent. The hair remains normal in the early stages, but later becomes rough and dry-looking and in some cases partly falls out. The erythema mentioned by so many writers is not a constant or even frequent symptom in this epidemic. The bowels and appetite are usually normal, and no significant changes are observed in the urine. When the disease is well established, the animal stands with head down, listless and dejected, and when forced to move, does so in a very sluggish manner.

The mucous membranes are pale, with a small watery discharge from the eyes and nose and often small petechiæ, especially of the conjunctivæ. Edemas, usually beginning in the sheath or the hind legs, are noticed and in protracted cases, before death become the most noticeable features of the disease. The edema from the genitals spreads along the belly, eventually forming a large band, which, if the animal lives long enough, may extend forward to the chest, Edema of the front legs is less common and pronounced, but does not occur in animals living for a long time, as is the case with mules and some horses. In animals living but a short time, edema may be entirely absent.

Paresis, especially of the hind parts, is a very common symptom in the later stages, and while never reaching true paralysis, coördination may become so poor that the animal falls to the ground. This condition may last for a few days until death ends the struggle. In some cases, more rapid in their course, the paresis may be scarcely perceptible.

During the period of incubation, there are no known means of diagnosis. During the early stages of the disease, microscopic examination of the blood is the only method of arriving at a correct

diagnosis. Later on, a week to ten days after the initial rise of temperature and depending somewhat upon the rapidity of the course, a positive diagnosis can readily be made by a simple inspection. The fever, anemia, beginning edema, paresis, emaciation and general appearance of the animal make a characteristic picture. Finally, when the edema is marked, a diagnosis is easily made at some distance from the animal.

In this country, with the disease constantly present, and where early diagnosis is of so much importance in the interest of healthy animals, a horse's blood should be examined microscopically as soon as a rise of temperature is noticed. The parasites are usually found in fairly large numbers when the animal has temperature; when the disease is well established, they are almost constantly present in sufficient quantity to render easy a microscopic diagnosis. The course varies considerably, being from two to six or eight weeks in horses and somewhat longer in mules. Complications are not very frequent in this country. Broncho-pneumonia is occasionally observed, and venous thrombosis sometimes occurs. Under our observation there have been two horses in which glanders and trypanosomiasis were associated.

Contrary to the statements of some writers upon the subject, in this country, the disease is invariably fatal in the horse.

PREVENTIVE MEASURES.

1. Prevention of reinfection of the country by proper quarantine laws.

2. Eradication of the present infection by enforcing efficient sanitary regulations.

It is believed that the methods to be described are practicable and, if adopted, will prove sufficient to control the epidemic and eventually to eradicate it from the country, but to give the best results work should be begun at once, during the dry season, while the cases are comparatively rare and before the wet season comes with its great increase in the number of biting flies and the consequent spread of infection.

Had vigorous methods been adopted when the disease first appeared in this country in 1901, there would not have been an epidemic, and even now, were proper procedure followed persistently, the disease should be eradicated from the Islands. If,

however, no more efficient course is adopted than the one in use now, the disease will go on spreading until the whole country is involved and the epidemic becomes perpetuated, as it has been in Africa, South America, India, and other countries.

The subject is an all-important one to the country, and it is imperative that facts and suggestions as to remedies be placed before our legislators. Without legal authority, municipal sanitation (as history so well demonstrates) must always be a failure, but with the authority given by proper ordinances, a disease such as trypanosomiasis of horses should be controlled from the start and finally eradicated from any country in which it has obtained a foothold.

In considering quarantine regulations against the introduction of trypanosomiasis into a non-infected country, a safe but hardly justifiable procedure would be to forbid the entrance of any animals from an infected port, as was so promptly done by the United States against the Philippine Islands when the disease was first reported here. Whether our home country enforces the same stringent laws against all others infected with trypanosomiasis and against all animals which have been in infected countries but are shipped to America from non-infected ports, can not, without full knowledge of the quarantine laws, be stated, but, granting this to be so, there still remains reasons for stating that there must be forces other than quarantine laws which prevent the introduction of trypanosomiasis into the United States. Wild animals for circuses and other purposes are certainly admitted in considerable numbers from infected countries, and when we consider the fact that many of these animals harbor the parasite without inconvenience, the introduction of the infecting agent into America at some time or other seems very probable. Not alone quarantine laws, but other factors, such as possibly conditions of temperature, moisture and carrying agents, probably play a part in preventing the spread of the disease.

However, trypanosomiasis has gained admission to the Philippine Islands, and so far as we are concerned, there is no need of discussing the quarantine laws necessary to prevent infection in a virgin country. It would have been entirely feasible, as is shown by accumulated experience, to have prevented the introduction of the disease into the Philippine Islands with its subsequent disas-

trous results by the enforcement of proper quarantine regulations without actually prohibiting the importation of animals. That this was not done is owing to the fact that the disease was not recognized until after its introduction and to our inexperience in dealing with tropical conditions, but it would appear in place to sound a note of warning to other countries, especially those within the geographically infected zone, and which are as yet without the disease. It is a question of economic importance second to none in a large area of the world, and deserves the closest attention and prompt action of the sanitary guardians of the public welfare.

The majority of the recommendations of writers from this and other countries deal more particularly with the destruction of flies as a means of controlling the infection, which, if a practical procedure, would probably give good results, but, except perhaps in certain stables and in small localities, this would be absolutely impracticable as a general method.

The accumulated evidence of scientific literature and the deductions of our own experiments are so strongly against the theory that food and water are to be considered in the transmission of the disease that no further consideration will be given it in this preliminary report.

In dealing with such a widely spread epidemic, the first essential is satisfactory ordinances; secondly, efficient sanitary officials; and lastly, coöperation between sanitary officials and others charged with the execution of the laws.

It should be the duty of each Government official to report every sick horse he observes to the Board of Health, and sanitary inspectors, in making their rounds, should be required to take cognizance of the physical condition of horses in their respective districts, reporting to the Board of Health any that appear ill.

As soon as the report of a sick animal is received, the Board of Health should send a competent man to inspect it, and if it has "surra" it should immediately be killed and if possible at once transferred to a crematory in a fly-proof wagon; if this it not practicable, the body should be protected from insects for twenty-four hours, either by a coating of earth or by a mosquito bar, or in any other efficient manner. After the expiration of twenty-four hours it may be disposed of as desired.

If, after a careful examination of a sick animal, the diagnosis of trypanosomiasis is doubtful, the animal either should be protected